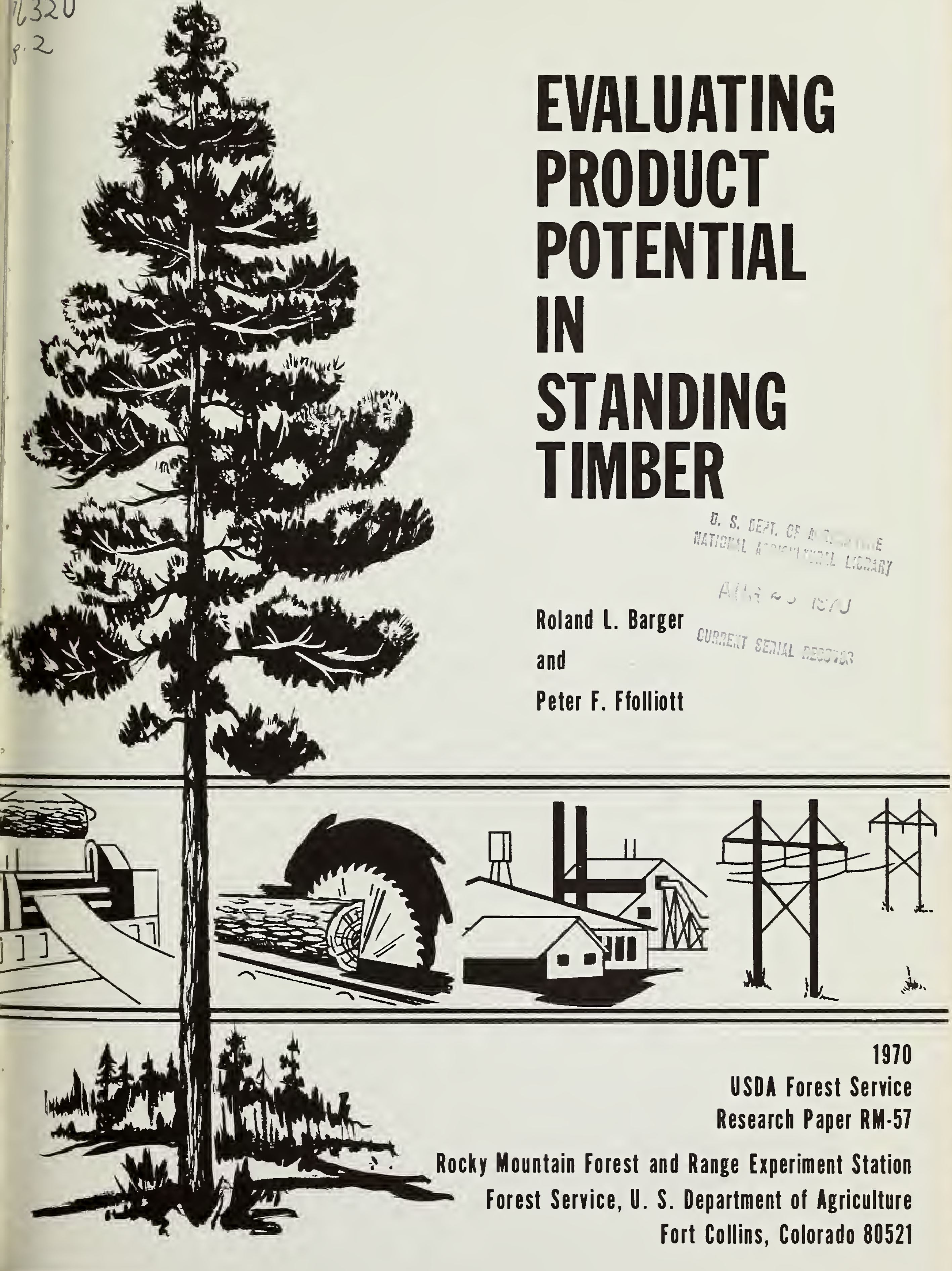

EVALUATING PRODUCT POTENTIAL IN STANDING TIMBER

Roland L. Barger
and
Peter F. Ffolliott

1970
USDA Forest Service
Research Paper RM-57
Rocky Mountain Forest and Range Experiment Station
Forest Service, U. S. Department of Agriculture
Fort Collins, Colorado 80521

FOREWORD

This paper describes and illustrates a method for evaluating product potential in standing timber. The method will

... minimize observer bias in stand quality inventory;

... provide a record of the occurrence of stem features that affect product quality and yield;

... describe suitability of the standing timber for a broad range of primary products;

... provide primary product quality and yield estimates for management and utilization decisions;

... provide a continuing basis for such decisions.

ABSTRACT

The timber quality inventory described recognizes and measures the basic stem characteristics and defect features that influence quantity and quality for most primary products. Stem features measured on sample trees include form defects, scar defects, and knot or limb characteristics. Timber inventory data obtained are used in conjunction with standard methods of estimating volume, scaling, and grading to estimate:

(1) Gross volume suitable for a primary product;

(2) Probable volume reduction due to visual scaling defects, and remaining net volume suited to the product;

(3) Quality of the timber in terms of existing grading or quality classification systems.

USDA Forest Service
Research Paper RM-57

1970

Evaluating Product Potential in Standing Timber[1]

by

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and

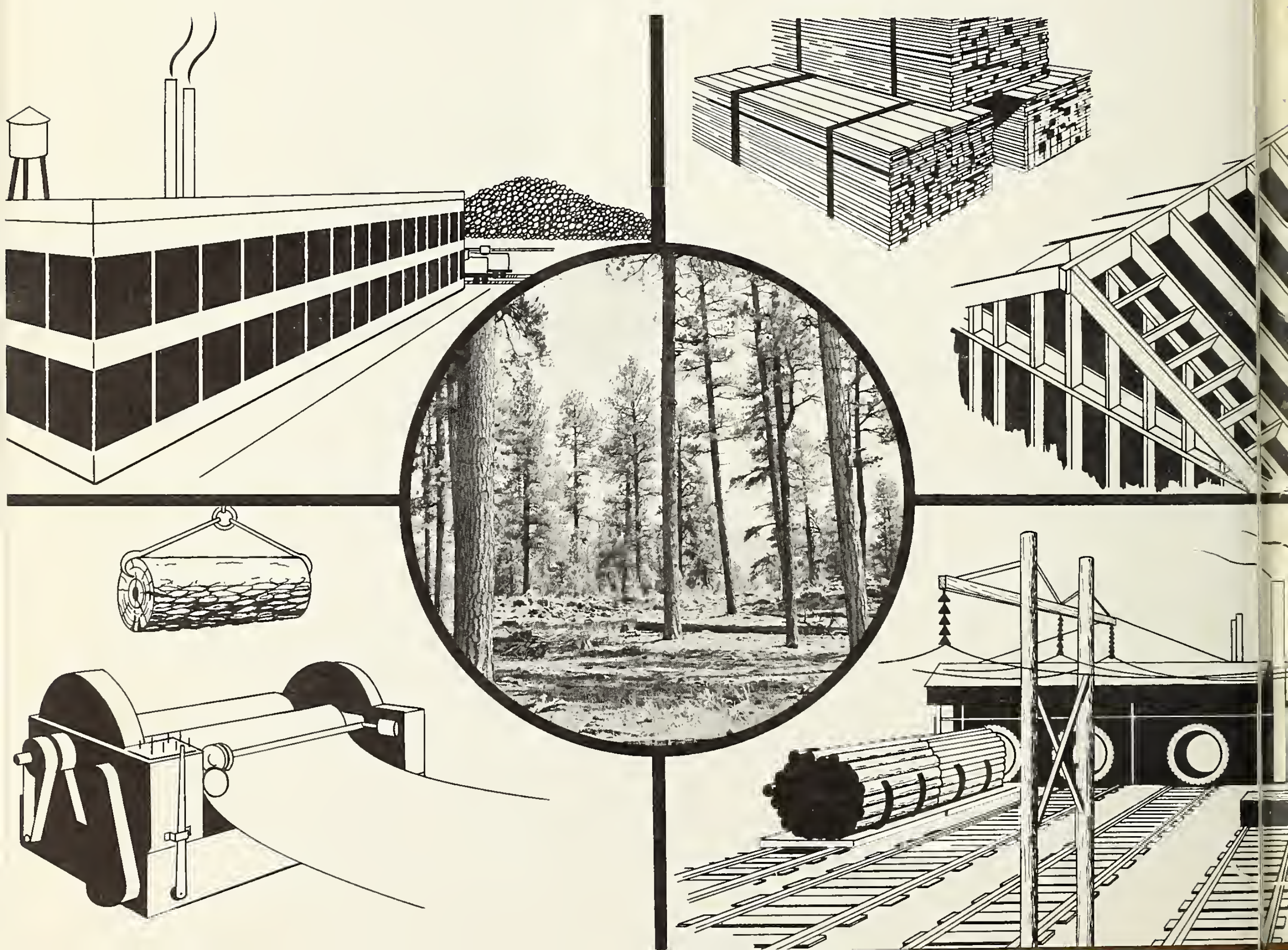
Peter F. Ffolliott, Associate Silviculturist

Rocky Mountain Forest and Range Experiment Station[2]

[1]This paper supersedes U. S. Forest Service Research Paper RM-15, "A method of evaluating multiproduct potential in standing timber," issued in October 1965.

[2]Forest Service, U. S. Department of Agriculture, with central headquarters maintained at Fort Collins, in cooperation with Colorado State University; research reported here was conducted at Flagstaff, in cooperation with Northern Arizona University. Ffolliott is currently Research Associate, University of Arizona, Tucson.

Contents



Evaluating Product Potential in Standing Timber

Roland L. Barger and Peter F. Ffolliott

Accent on Quality

Patterns of forest utilization are changing, with added emphasis on new products, new conversion methods, and broader product diversification. Industry trends are toward utilization complexes capable of producing a range of products. These changes call for improved methods of evaluating timber quality.[3] Estimating product potential in standing timber is particularly complicated by the array of products that may warrant consideration. Inventory methods are needed that permit evaluating suitability for all primary products of interest. Ideally, such methods should estimate both quantity and quality of timber suited to each product.

An inventory of timber quality should identify and measure in standing timber the fundamental stem characteristics related to quality and yield. Inventory information may then be interpreted in terms of any existing or proposed grading or quality classification system to estimate suitability of the stand for primary products of interest.

To be most effective, quality inventory methods should avoid applying single-product grading systems directly to standing timber. Stem quality described in terms of a single set of fixed grades is entirely inadequate for multiproduct evaluation. In addition, conventional grading systems are subject to frequent revision, refinement, and regional modification. Basic quality information can be independent of specific grading systems, yet adaptable to any grading system or set of quality criteria in use. Changes in quality requirements or grading specifications for a product then require only a reevaluation of the basic stem quality data originally inventoried.

The detail incorporated in an inventory system must necessarily be a compromise between information desired and time and effort required to get it. A workable inventory system cannot be encumbered with so much detail that it becomes too difficult and time consuming to apply on the ground. Consequently, an inventory of timber quality must record major stem characteristics that affect quality or yield, under relatively broad classifications of severity of defects.

The purpose of this Paper is to describe a method of inventorying quality in standing timber, and using the resulting quality data to estimate potential for a variety of primary products. The system has been developed in southwestern ponderosa pine (Pinus ponderosa Laws.) stands, for the range of primary products for which ponderosa pine is potentially suited (fig. 1). The basic methodology can be applied with little difficulty to other areas and other species.

[3] *Timber quality, as used here, refers to degree of suitability for one or more primary products.*

Figure 1.--Mature stands of ponderosa pine timber are well suited to a wide variety of products. Improved methods of evaluating timber quality are needed to guide choices between alternative products.

Design of the System

Quality for most primary products is largely determined by the same few stem features—stem form defects, scar defects, and presence of knots or limbs. Stem form and scar defects are also the major visual scaling defects in log products. Design of the inventory system requires that such defects be classified or measured by field crews, along with more conventional information such as species and size. Estimates of quality and quantity of timber suitable for any or all primary products of interest are subsequently determined by office or automatic data processing (ADP) procedures.

In developing the methods used, major design considerations were:

(1) To recognize or measure basic stem characteristics and defects that are common grading and/or scaling criteria for most primary products;
(2) To minimize quality evaluations by inventory crews (that is, minimize observer bias) by avoiding field use of conventional tree or log grading systems;
(3) To strike a reasonable compromise between information desired and time and effort required to conduct the inventory.

Quality-related Stem Characteristics

The inventory system relies upon observation or measurement of the following visual stem characteristics, all directly related to timber suitability, grade, or volume for one or more primary products:

Tree stem characteristic	Implications for use, quality, quantity	Inventory data needed
Species	Indicates range of primary products for which stem may be considered.	Species
Age class or form class	Basic indicator of merchantability for some products such as commercial poles. May contribute to volume estimation.	Class such as "blackjack"
Size	Basic indicator of merchantability for all primary products. Determines gross volume for all primary products.	D.b.h., height
Sweep	Limits use for products requiring straight stem. Scaling defect in log products.	Severity
Crook	Limits use for products requiring straight stem. Scaling defect in log products.	Severity and location
Fork	Inadmissible in all primary products. Associated crotch and distorted grain a scaling defect in log products.	Location
Lean	Indicator of possible reaction wood, limiting use for some products.	Severity
Fire or basal scar	Limits use of portion of stem. Scaling and grading defect in log products.	Extent
Lightning scar	Limits use for some products. Scaling and grading defect in log products.	Extent
Knots or limbs	Use for some products limited by knot size. Primary grading criteria for all log products.	Occurrence (number, type, size); distribution

The stem characteristics included are those most indicative of product potential for the range of primary products obtained from ponderosa pine and associated softwood species. Observed stem quality characteristics may be revised for application to other species with significantly different product possibilities.

Sampling Design

The inventory system is concerned primarily with how to observe, record, and interpret the characteristics and defects of individual sample trees. Sampling techniques are not of direct concern. Any valid sampling system that meets timber inventory

W.S. NO. 10 POINT NO. 142 ASPECT W SITE II DATE 6-21-68

LINE NO. 4C SLOPE % 10 SOIL TYPE SIESTA-SPONSELLER CREW RB-PF

NO.	SPP.	D.B.H.	HT.	POLE HT.	SW	CR	FK	LN	FS	LS		0-8				8-16				16-24				24-32
												1	2	3	4	1	2	3	4	1	2	3	4	
1	YP	30.1	102	-	-	1/3	6	10	2	1	KN	2	-	3	8	4	-	5	5	6	3	8	9	
											L	-	-	-	-	-	-	-	-	2	-	7	5	
											D	3	-	2	4	3	-	4	4	4	6	5	6	
2	BJ	16.5	68	45	1	-	-	5	-	-	KN	-	4	2	2	4	5	6	4	10	8	7	5	
											L	-	-	-	-	1	1	2	2	2	1	1	2	
											D	-	1	1	1	-	1	1	1	2	2	1	1	
3		ETC.										ETC.												

SW - SWEEP MINOR (1), MAJOR (2)
CR - CROOK MINOR (1), MAJOR (2), AND HALF-LOG
FK - FORK HALF-LOG POSITION
LN - LEAN 5-DEGREE CLASS
FS - FIRE SCAR MINOR (1), MAJOR (2)
LS - LIGHTNING SCAR MINOR (1), MAJOR (2)

		0-8			
LOG POSITION					
LOG FACE		1	2	3	4
NO. KNOTS	KN	2	-	3	8
MAX. LIVE (IN.)	L	-	-	-	-
MAX. DEAD (IN.)	D	3	-	2	4

(ONLY CLEAR FACES ARE RECORDED FOR POSITION 24-32)

Figure 2.--Inventory information on stem quality can be recorded for sample trees on a field data sheet or card with the format illustrated. The entries shown illustrate the manner in which major stem features of two sample trees might be recorded.

sampling objectives can be used as the "vehicle" for the quality inventory system. Reliability of estimates drawn from inventory data will depend, however, upon sampling procedure and intensity.

Recording Inventory Data

Stem quality information is obtained from each sample tree designated by the sampling scheme used. Quality inventory has generally been limited to trees large enough to produce pole or log products. Quality information for smaller trees may be useful, however, in indicating probable suitability of the future timber crop for specific primary products.

Inventory information may be recorded on field data cards or sheets (fig. 2), or may be punched on coded Port-o-punch[4] data cards. Both methods have been used without difficulty.

[4]*Trade names and company names are used for the benefit of the reader, and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

The specific measurements or classifications used in recording field information include:

Stem characteristics	How determined	Classification
Species	Observation	Species
Age class or form class	Observation	Class: (for ponderosa pine, coded under species as YP--yellow pine, BJ--blackjack).
Size	Measurement	D.b.h. in inches.
		Total height in feet or in logs (sample as required for volume determination).
		Pole height (where applicable) as maximum 5-foot height class.

Stem characteristics:
Sweep (fig. 3)

How determined:
Estimation

Classification:

<u>Class 1</u> (Minor)--Deviation of merchantable stem, in inches, less than tree d.b.h.

<u>Class 2</u> (Major)--Deviation of merchantable stem, in inches, equal to or greater than tree d.b.h.

<u>Note</u>: Sweep judged to be less than 1/3 tree d.b.h. is not considered a defect, and is ignored.

Figure 3.--Sweep, defined as a gradual bend in the merchantable stem, affects suitability and yield for many end uses.

Stem characteristics:
Crook (fig. 4)

How determined:
Estimation and measurement of location

Classification:

<u>Class 1</u> (Minor)--Deviation of stem in inches, less than 1/2 diameter of stem at crook.

<u>Class 2</u> (Major)--Deviation of stem, in inches, equal to or greater than 1/2 diameter of stem at crook.

<u>Location</u>: Half-log (8-foot section) height in tree.

Figure 4.--Crook, an abrupt bend in the merchantable stem, is a common grading and scaling defect.

Stem characteristics:
Fork (fig. 5)

How determined:
Measurement of location

Classification:
Location: Half-log (8-foot section) height in tree.

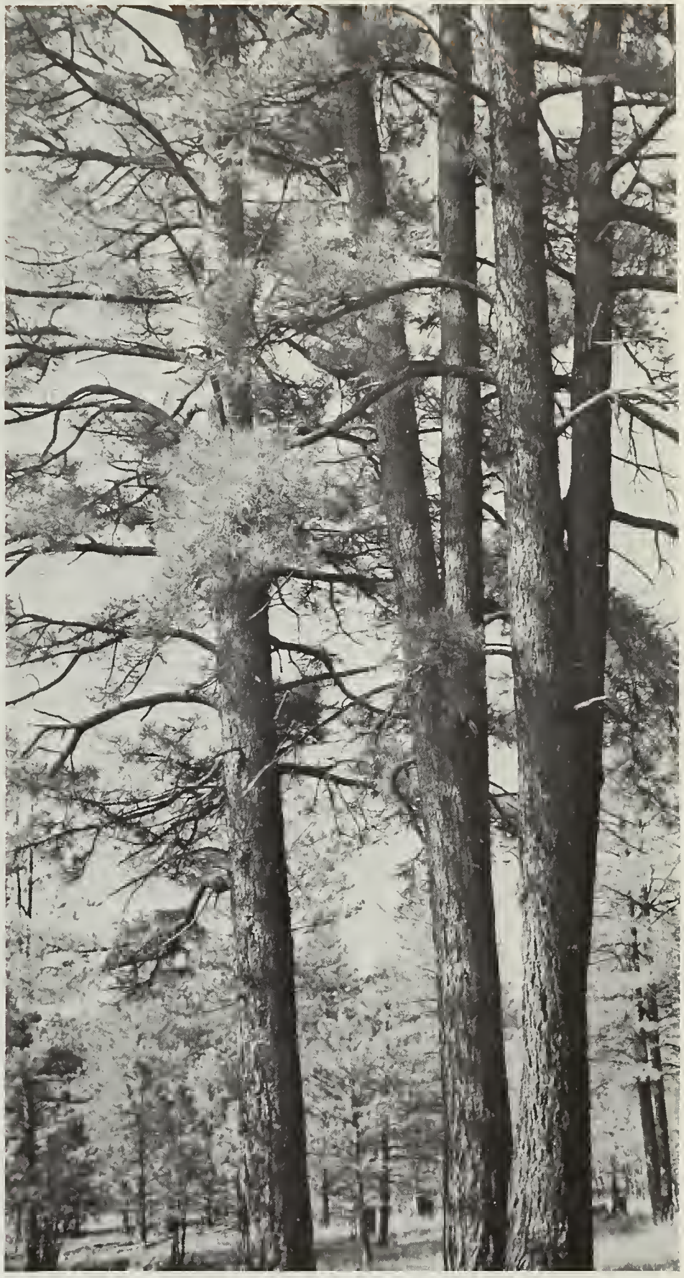


Figure 5.--A fork, or division of the merchantable stem, affects both yield and grade.

Stem characteristics:
   Lean (fig. 6)

How determined:
   Measurement, using plumb-bob device (fig. 7)

Classification:
   <u>Class</u>: 5-degree classes.

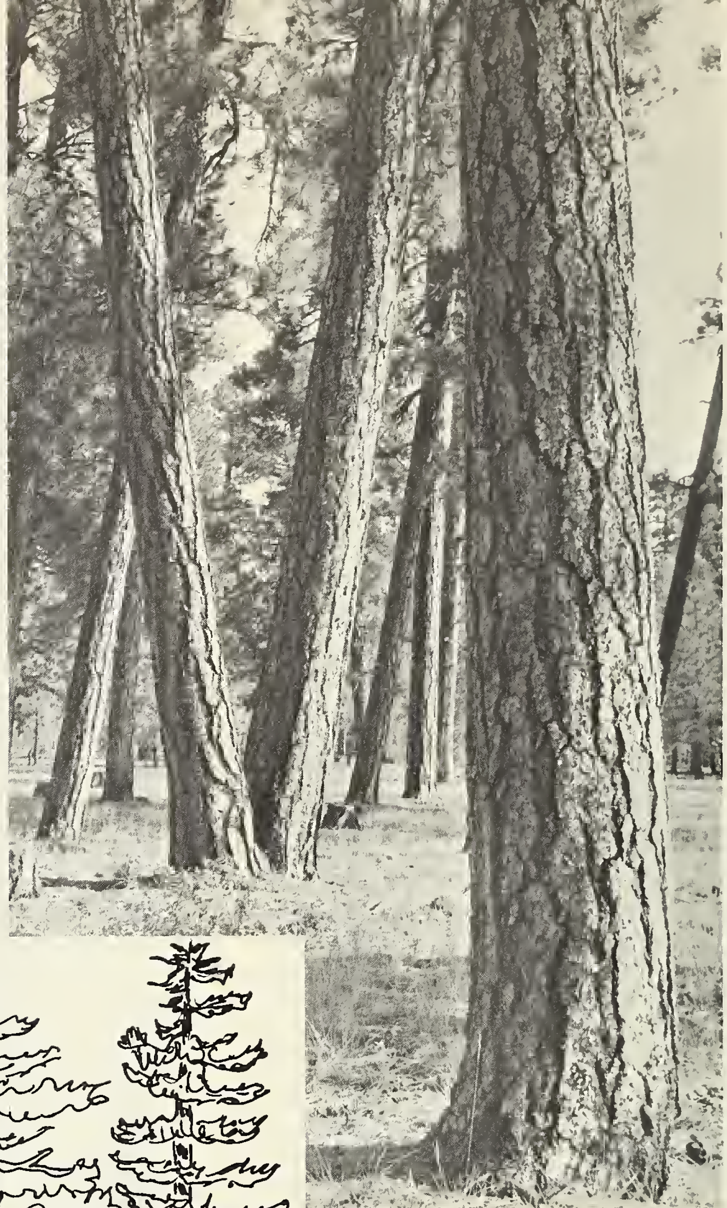


Figure 6.--Leaning stems frequently develop compression wood, a limiting defect for many end uses.

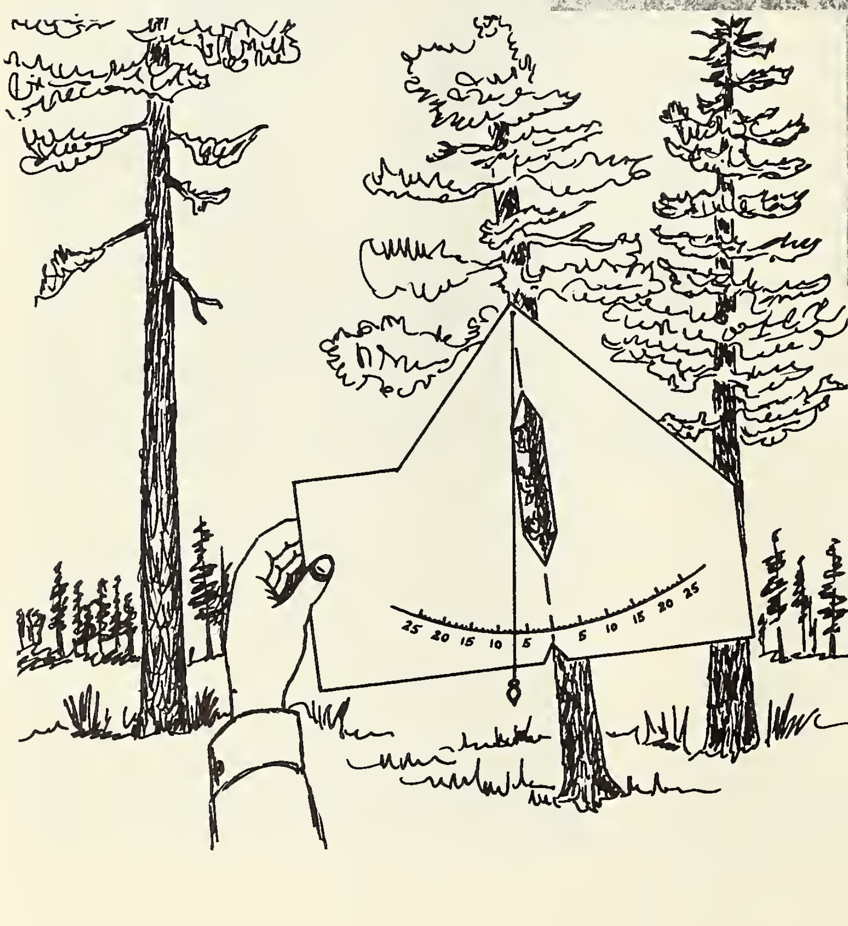


Figure 7.--A plumb-bob device can be used to determine degree of stem lean.

Stem characteristics:
Fire or basal scar (fig. 8)

How determined:
Estimation

Classification:
Class 1 (Minor)--Contained in one stem face (1/4 circumference).

Class 2 (Major)--Extends to two or more stem faces.

Figure 8.--Fire scars may affect one or more faces of the merchantable stem, but seldom extend far up the stem.

Stem characteristics:
Lightning scar (figs. 9, 10)

How determined:
Estimation

Classification:
Class 1 (Minor)--Essentially straight; contained in one stem face.

Class 2 (Major)--Spiral; extends to two or more stem faces.

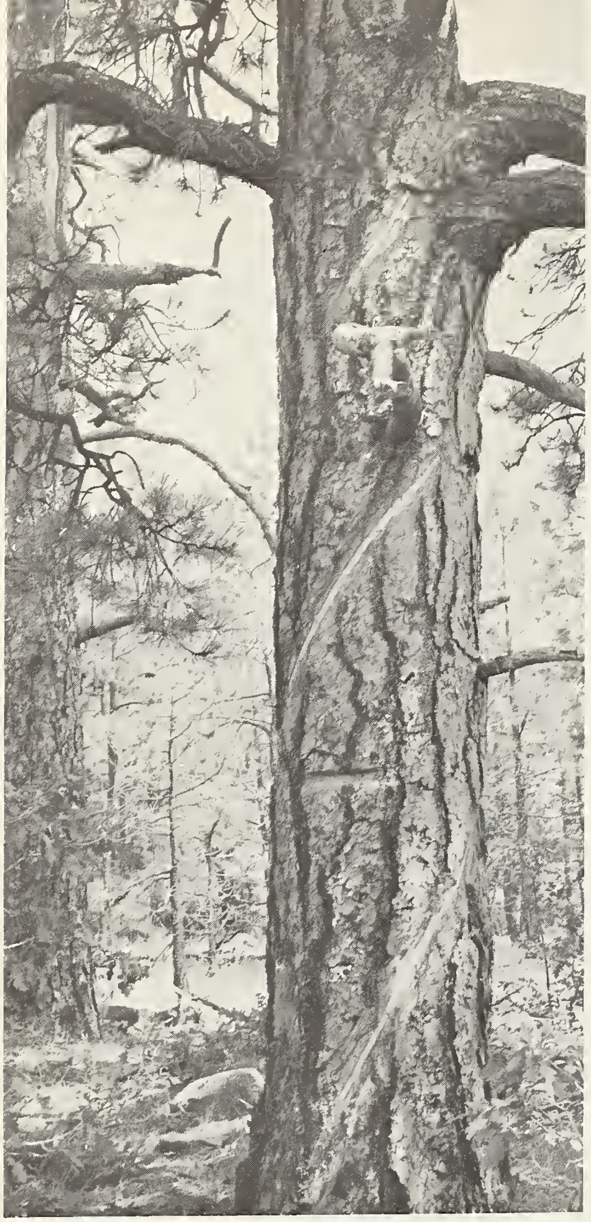


Figure 9.--Many lightning strikes cause only superficial physical damage to the merchantable stem. Depending upon the objectives of the inventory, this type of scar may be ignored, or may be recorded separately.

Figure 10.--Severe lightning scars and associated fire damage may warrant extensive grade and yield reductions.

Figure 11.--Poor pruning characteristics in open-grown stands can severely limit product potential. Knots or limbs are the most important single quality indicator for many primary products.

Figure 12.--Clear log faces indicate suitability and high quality for most primary products.

Stem characteristics:
Knots (figs. 11, 12)

How determined:
Count observation, and estimation

Classification:
For each face of first three merchantable half-logs (8-foot stem sections between stump and 24 feet):
- Number of knots in face,
- Size of largest live knot or limb to nearest inch,
- Size of largest dead knot or limb to nearest inch.

For fourth merchantable half-log (24 to 32 feet):
- Occurrence of clear half-log (8-foot) faces.

Knot features are the most difficult to observe and record in some meaningful manner, and at the same time are the most important quality indicator for many primary products. The system of knot count and size estimation by 8-foot stem section and log face was developed through trial and error. More detailed information for lower logs would require excessive inventory time, and knot information of any kind above 32 feet is not generally warranted by the grade potential of upper logs. Field crew training exercises have indicated that knot information observed and recorded as outlined is relatively consistent or reproducible among crews.

Field crews can use telescoping or jointed fishing rods, marked at stump height and at 8- and 16-foot levels above the stump, for locating 8-foot stem sections. The rod also serves as a reference point from which to estimate the four faces or panels of each 8-foot stem section.

The stem quality features observed are those believed most indicative of suitability and yield for a wide range of products. When other features are considered important in determining quality for particular uses, they may be added to the inventory. For example, density or specific gravity is a desirable index to suitability for some uses. Where it is of prime interest, increment cores can be taken from selected sample trees (fig. 13) and specific gravity determinations made. Increment cores or other visual indicators may be used to estimate occurrence of internal rot.

Interpreting Inventory Data

The timber inventory data obtained provide a means of readily estimating stand potential for a wide variety of primary products. The data are used in conjunction with standard methods of volume estimation, scaling, and grading to estimate:

(1) Gross volume suitable for a primary product;

(2) Probable volume reduction due to visual scaling defects, and remaining net volume suited to the product;

(3) Quality of the timber in terms of existing grading or quality classification systems.

Figure 14 illustrates the manner in which inventory data are combined with existing methods of estimating volume and grade.

Figure 13.--Where wood quality or internal defect is of particular interest, increment cores can be taken from selected sample trees for further analysis.

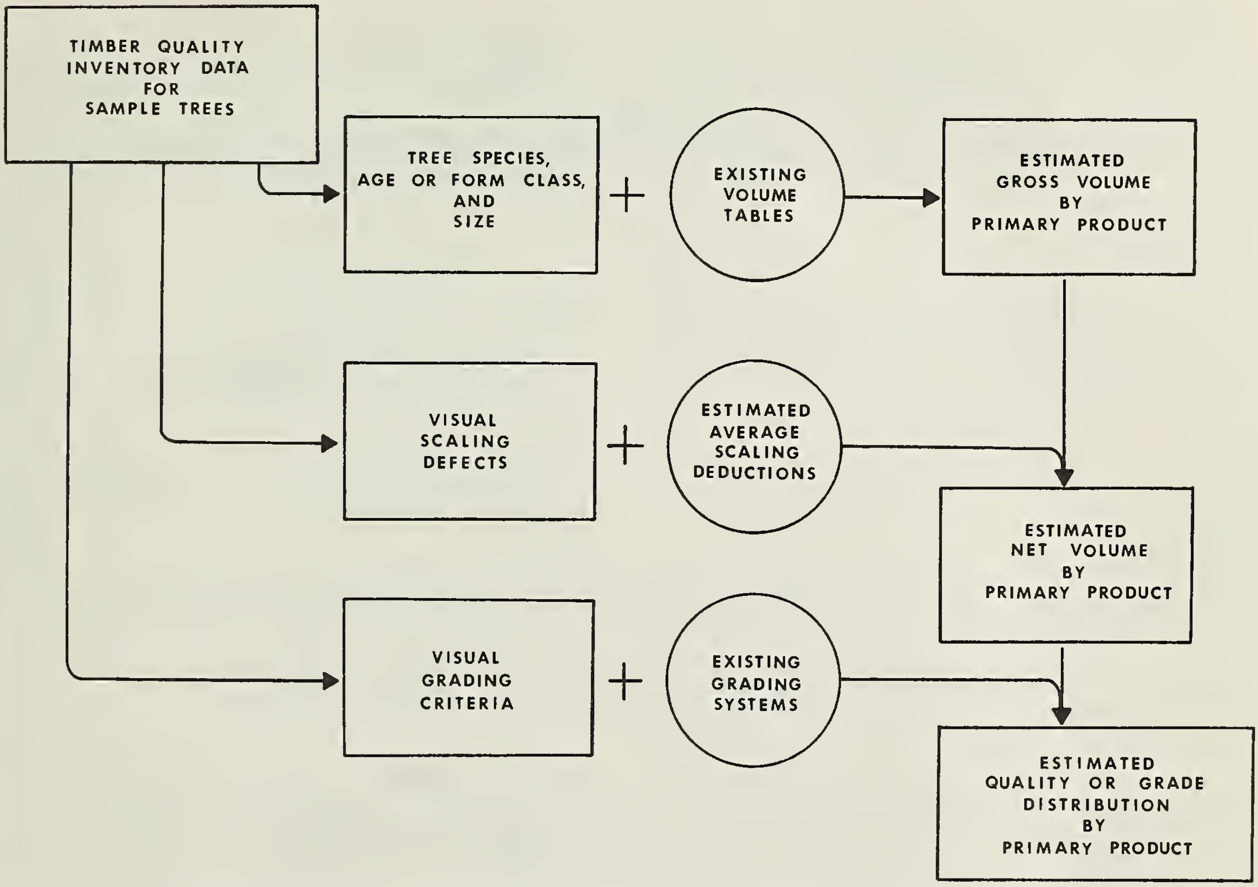


Figure 14.--Inventory data for sample trees are used in combination with standard procedures for estimating volume, scaling, and grading to evaluate primary product potential.

Inventory data can be analyzed by hand or by computer procedures. Since the quality of the sample trees must be evaluated individually, machine data processing methods offer considerable advantage. Initial data preparation depends upon which method is to be used. For computer analysis, all inventory data for each tree are punched on data cards. All inventory information described can be placed on one card per tree (fig. 15). Subsequent analysis for each product can be programed.[5] If hand analysis is used, the procedure can be facilitated by first aggregating inventory data into a series of stand tables showing number of trees per acre and frequency of occurrence of each type of stem defect, by tree diameter classes.

[5] *A computer program developed to analyze product potential, using the described timber inventory data, has been prepared by Jack D. Heidt and Donald A. Jameson in "Determining timber conversion alternatives through computer programing," unpublished manuscript, Rocky Mt. Forest and Range Exp. Sta., Flagstaff, Ariz.*

Estimating Gross Volume

Gross volume for most primary products is the total volume contained in trees of acceptable size and form. Gross volume for each product of interest is obtained by applying standard or localized volume tables to the tree stand table developed from inventory data. Size limitations for a product will initially determine the timber to be included in gross volume. Stem size limitations used in estimating gross product volumes in ponderosa pine timber are indicated in table 1. Other stem characteristics may also occasionally be used to define gross product potential; commercial pole potential, for instance, may include only stems of a particular form or age class in addition to size limits.

Estimating Net Volume

Net volume for each product is obtained by estimating reductions in usable material due to visual

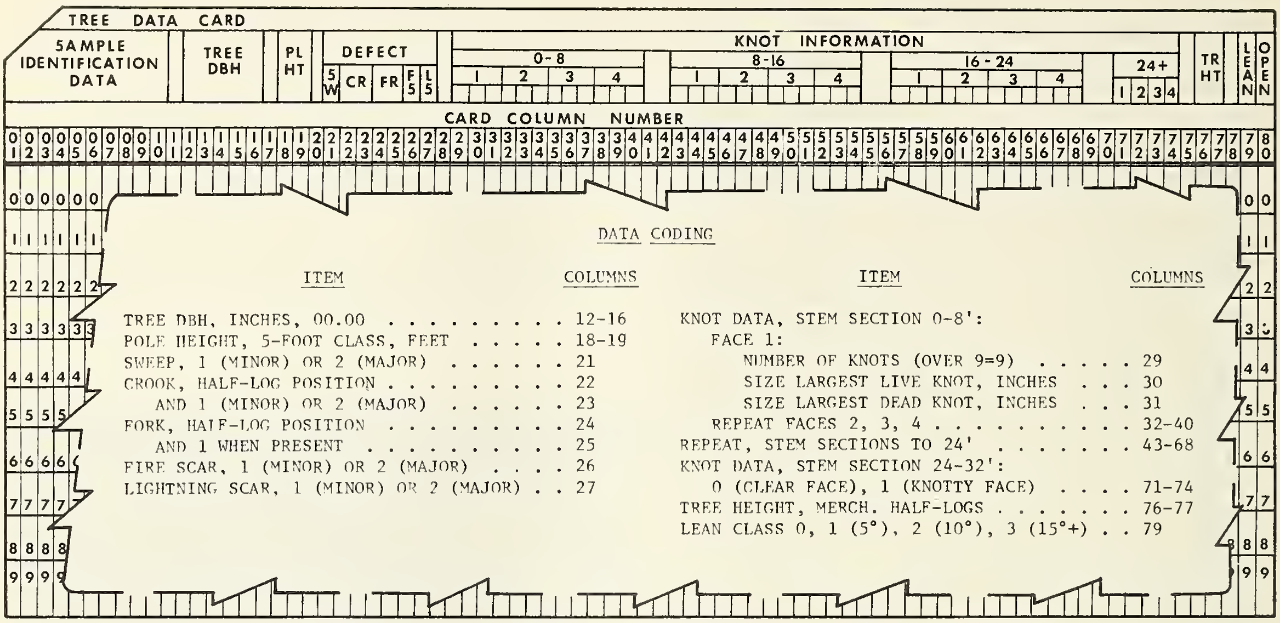


Figure 15.--To facilitate computer analysis of inventory data, all information for one sample tree can be punched on a single data card with the format illustrated.

Table 1.--Stem characteristics used in estimating suitability, volume, and grade for primary products in ponderosa pine

Primary product	Stem size limitations	Visual defects limiting use or reducing usable volume (scale)[1]	Visual grading criteria	Nominal product unit
Saw logs	Tree d.b.h., 11.0 inches and over	Sweep, crook, fork, fire and basal scar, lightning scar	(First 32 feet) Knot number and distribution; scar defects	Board feet, 16-foot logs
Veneer logs	Log scaling diameter, 10.0 inches and over[2]	Crook, fork, fire and basal scar, lightning scar	(First 24 feet) Dead knot size; live knot size	Board feet, 8-foot logs
Stud logs	Log scaling diameter, 6.0 to 16.9 inches[3]	Crook, fork, fire and basal scar, lightning scar	(First 24 feet) Knot number; dead knot size; live knot size	Board feet, 8-foot logs
Commercial poles	Tree d.b.h., 9.0 to 20.9 inches	Sweep, crook, fork, lean, fire and basal scar, lightning scar, oversized knots	Merchantable pole height; tree d.b.h.	Piece count, 5-foot height classes
Pulpwood	No limit in initial evaluation	Crook (in groundwood), fire scar, lightning scar	None	Cubic volume

[1]Includes defects that either prohibit use of the stem or stem section for the product, or reduce merchantable volume for the product.
[2]Limits stem sections evaluated for veneer to first section in trees in 12-inch diameter class; first and second sections in 14-inch class trees; three sections in all trees larger.
[3]Limits stem sections evaluated for studs to three sections in trees in 18-inch and smaller diameter classes; second and third sections in 20-inch class trees; third section in 22-inch class trees; none in larger trees.

stem defects. Defects considered to affect suitability or volume for primary products in ponderosa pine are shown in table 1. Depending upon the primary product being evaluated, recorded stem defects may prohibit use for the product altogether, or may reduce usable volume for the product. For example, major crook will prohibit use of a stem for a pole, but will only reduce usable volume or scale in a saw log.. For those defects judged to prohibit use for the product, gross volume (or count) is reduced by the volume (or count) contained in trees or tree sections with the defect. Examples are

removal of trees with recorded sweep from gross stem count for pole potential, and removal of 8-foot stem sections with major crook from gross volume for veneer logs.

For defects judged to reduce usable volume for a product (scaling defects), average scaling deductions are applied to gross volume. Average scaling deductions for each type of defect may be estimated by referring to standard scaling procedures and methods (Grosenbaugh 1952, U. S. Forest Service 1964). As an example, average deductions used in evaluating product potential in ponderosa pine included:

Visual scaling defect	Scale deduction applied
Sweep	
(1) Minor	None (largely removed in bucking).
(2) Major	Deduct 20 percent of merchantable volume in entire stem.
Crook	
(Minor and major)	Deduct volume equivalent to 4 feet of length of log in which it occurs (25 percent of 16-foot log).
Fork	Deduct volume equivalent to 4 feet of length of log in which it occurs (25 percent of 16-foot log).
Fire or basal scar	
(1) Minor	None (contained outside right scaling cylinder).
(2) Major	Deduct volume equivalent to 2 feet of length of butt log (12-1/2 percent of 16-foot log).
Lightning scar	
(1) Minor	Deduct 25 percent of volume in entire stem.
(2) Major	Deduct 50 percent of volume in entire stem.

Computer techniques will include the capability to scan defect data by individual tree and stem section, and make specified corrections to gross volume for each product. If calculations are being performed by hand, however, it is most convenient to start with stand tables showing gross product volume by log position and tree diameter class. Scaling deductions can then be applied by log position (where applicable) and tree diameter class. For a particular scalable defect and tree diameter class or log position, corrections to gross volume may be calculated as:

Percent occurrence of defect	X	Percent scaling deduction	=	Percent correction to gross volume

Diameter class information can then be combined to show total deductions by defect type, and total net volume for the primary product being considered.

Estimating Grade or Quality Class

Quality or grade of the net volume of material acceptable for each primary product is also important. Choices between alternative products will frequently be based upon the apparent grade of the timber for each potential product. For some primary products such as poles, quality may be adequately expressed by height and diameter class. For others such as saw logs and veneer logs, an estimate of log grade distribution is needed. Grade or quality class is estimated by interpreting recorded stem quality information in terms of existing grading systems. The precision with which grades or quality classes can be estimated depends largely upon the nature of the grading system being used. More complicated grading systems will obviously require more extensive interpretations of the data.

Quality evaluation can be accomplished either by programed computer procedures or by hand. In either case, each sample tree must be evaluated individually. Hand evaluations can be made directly from field data cards similar to that in figure 2.

Grading systems for conversion products such as saw logs and veneer logs necessarily include only visible stem characteristics as grading criteria. Most are based primarily on size, number, and distribution of log knots. Consequently, the grade of a log can be estimated by comparing recorded stem defect data with grade specifications. Depending upon the grading system used, this may involve scanning knot data only, or may require additional consideration of scars and stem form defects.

Using Inventory Data — An Example

Methods and procedures for interpreting inventory data have thus far been discussed in general

terms. They can best be clarified and illustrated in an example. The following analysis is an actual application of the inventory system in estimating the product potential of a timber stand.

The Area and Timber

The example area is a 430-acre watershed in cutover ponderosa pine. Timber was last logged from the area 20 years ago, leaving approximately half of the merchantable volume in the residual stand. The current stand includes approximately 85 percent ponderosa pine and 15 percent associated woodland species. Pine timber was inventoried on the area, by means of the quality inventory methods described, with a sample design of 200 point samples systematically located along multiple random starts.

Basic inventory data for the stand were aggregated into stand tables in preparation for hand analysis. Stand data and stem defect occurrence data are summarized in table 2. Knot data were "read" directly from inventory cards when needed to complete the analysis.

Primary Product Potential

For the locality and timber used in the example, five primary products were considered: saw logs, veneer logs, stud logs, commercial poles, and pulpwood. Although local markets are not currently active for all these products, their development in the near future seems imminent. The manner in which recorded quality data can be applied in estimating product potential is amply demonstrated by this group of products.

Saw log potential.—All timber in diameter classes 12 inches and larger was considered potential sawtimber. Gross volume of this timber was obtained by converting stand measurement data into board feet Scribner scale by means of volume tables (Myers 1963). A high proportion of the merchantable volume was contained in butt 16-foot logs, and only a minor proportion occurred above the second log. The gross volume in each diameter class and proportion of volume by log position is shown in the left-hand columns of table 3.

Net saw log volume was estimated by adjusting gross volume for visual defect. For the timber considered, major sweep, crook, fork, and fire and lightning scars will reduce usable saw log volume. Deductions within each tree diameter class were calculated for each of these defects by applying inventory defect occurrence data and the average scale deduction factors previously described (page 13).

For example, the scale deduction for crook in the 16-inch tree diameter class was calculated as:

Table 2.--Ponderosa pine timber stand, per acre basis, and percent of stems with defect, on example area

Tree d.b.h. class (Inches)	Trees per acre	Volume per acre	Summary of stem defect occurrence															
			Sweep		Crook			Fork			Lean			Fire scar		Lightning scar	
			Minor	Major	First log	Second log	Over	First log	Second log	Over	5°	10°	15°+	Minor	Major	Minor	Major
	Number	Board feet	- - -	- - -	- - -	- - -	- - -	- - -	- Percent -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
8	22.50	--	3.0	3.2	10.0	1.6	0	0	0	0	8.0	1.6	0	.0	1.6	0	0
10	13.00	196	2.0	1.8	9.0	3.6	0	0	0	0	10.8	1.8	0	0	0	0	0
12	7.43	334	0	0	8.6	6.2	0	0	0	0	8.7	0	2.2	0	0	0	0
14	2.14	161	0	0	10.6	0	0	0	0	0	16.0	5.3	0	0	0	0	0
16	1.82	200	5.0	4.9	9.8	4.9	0	0	4.9	0	14.8	19.8	0	0	0	0	0
18	2.23	357	9.0	10.3	6.8	0	0	3.4	0	0	20.6	6.7	3.4	0	3.4	0	6.7
20	1.40	348	0	0	4.1	4.1	0	0	4.1	8.0	28.3	4.1	8.3	4.1	0	4.1	4.1
22	1.68	596	0	0	2.9	2.9	0	0	0	0	28.6	8.3	2.9	2.9	0	0	5.9
24	1.13	521	0	0	0	7.0	3.0	0	0	0	21.2	10.6	0	0	3.5	3.5	21.2
26	.79	471	4.0	3.6	0	3.6	4.0	0	3.6	8.0	29.3	3.6	3.6	0	0	3.6	8.5
28	.27	196	0	0	0	0	0	0	0	0	51.7	10.3	10.3	0	0	20.7	10.3
30	.13	112	0	0	0	0	0	0	0	0	0	0	0	13.3	0	0	13.3
32	.05	47	0	0	0	0	0	0	0	0	50.0	0	0	0	0	0	0
34	.02	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	.02	24	0	0	0	0	0	0	0	0	0	0	0	0	50.0	0	50.0
38	.03	49	0	0	0	0	0	0	0	0	0	0	0	40.0	0	0	40.0
Total	54.64	3,636	2.1	2.2	6.3	3.3	.6	.3	.8	1.1	17.4	4.7	2.2	1.1	1.1	1.4	4.7

Note: "--" indicates not applicable.

Table 3.--Analysis of saw log potential, per acre basis, in the example stand

Tree d.b.h. class (Inches)	Gross saw log volume				Deduction for visual defect						Net saw log volume[1] by log and grade							
	Per acre	Distribution by log			Major sweep	Crook	Fork	Major fire scar	Lightning scar	Total	First log		Second log		Upper log		Total	
		First	Second	Upper							Grade 3 & better	Grade 5	Grade 3 & better	Grade 5	Grade 3 & better	Grade 5	Grade 3 & better	Grade 5
	Board feet	- - - - - - - - - Percent - - - - - - - - -									- - - - - - - - - Board feet - - - - - - - - -							
12	334	89	11	0	0	2.1	0	0	0	2.1	0	290	0	37	--	--	0	327
14	161	80	20	0	0	2.1	0	0	0	2.1	0	126	0	32	--	--	0	158
16	200	73	27	0	1.0	2.1	.3	0	0	3.4	7	134	0	52	--	--	7	186
18	357	69	31	0	2.1	1.2	.6	.3	3.4	7.6	7	220	0	103	--	--	7	323
20	348	64	32	4	0	1.0	.3	0	3.1	4.4	17	196	0	107	0	13	17	316
22	596	59	31	10	0	.7	0	0	3.0	3.7	31	309	0	178	0	56	31	543
24	521	58	32	10	0	.6	0	.3	11.5	12.4	11	254	0	147	0	44	11	445
26	471	58	33	9	.7	.4	.3	0	5.2	6.6	36	219	0	143	0	42	36	404
28	196	58	33	9	0	0	0	0	10.3	10.3	10	91	0	58	0	17	10	166
30	112	57	34	9	0	0	0	0	6.6	6.6	12	48	0	35	0	10	12	93
32	47	55	34	11	0	0	0	0	0	0	0	26	0	16	0	5	0	47
34	24	53	32	15	0	0	0	0	0	0	12	0	0	7	0	5	12	12
36	24	50	30	20	0	0	0	3.1	25.0	28.1	9	0	0	5	0	3	9	8
38	49	49	29	22	0	0	0	0	20.0	20.0	10	10	0	12	0	7	10	29
Total	3,440	65	29	6							162	1,923	0	932	0	202	162	3,057

[1]Exclusive of volume reduction due to internal defect.
Note: "--" indicates not applicable.

Log position (Number)		Crook occurrence (Percent)		Log scale deduction (Decimal		Volume in log position fraction)		Defect deduction (Percent)
1		9.8	x	0.25	x	0.73	=	1.79
2		4.9	x	.25	x	.27	=	.33
Over		0	x	.25	x	0	=	0
Total scale deduction (percent)							=	2.12

The scale deduction for sweep in the same size class was calculated more simply, as:

Major sweep occurrence (Percent)		Tree scale deduction (Fraction)		Defect deduction (Percent)
4.9	x	0.20	=	0.98

Since sweep is considered to affect the entire merchantable stem uniformly, defect occurrence and volume distribution by log position do not have to be considered.

Scaling deductions for each type of visual defect, by tree diameter classes, are indicated in table 3. The resulting net volumes, exclusive of internal defect deductions, are also shown.

The improved 5-grade log-grading system (Gaines 1962) is currently recognized for ponderosa pine sawtimber. Quality of the saw log material was estimated by applying grade specifications for this system to recorded stem quality data. In this grading system, log knots are the primary grading defects, while scars and certain stem abnormalities are secondary defects. The grade of a log is determined by the amount of log surface (expressed in 4-foot log face "panels") free of grading defects. To estimate saw log grade for sampled trees, recorded defect information for first and second logs was scanned to determine number of defect-free "panels." Recorded data do not correspond exactly to the grading criteria used in this system, so some interpretive rules of thumb are necessary: one clear 8-foot face = 2 assured clear "panels," an 8-foot face with one knot = 1 assured clear "panel," and so forth. Estimated defect-free "panels" were accumulated for all faces of a log and the appropriate grade assigned the log as follows:

Estimated clear 4-foot panels (Full log--16-foot)	(Half log--8-foot)	Grade assigned (Number)
- - (Number) - -		
15 - 16	8	1
12 - 14	6 - 7	2
5 - 11	3 - 5	3
Less than 5	Less than 3	5

Saw log volume above 32 feet in the tree was assigned Grade 5.

An extremely small proportion of the saw log material qualified for Grades 1 and 2, and Grade 4 describes a type of log not commonly found in southwestern ponderosa pine. Consequently, quality

stratification was effectively limited to two classes—"Grade 3 and better" and "Grade 5." The distribution of net saw log volume by log grade and position is shown in the right-hand columns of table 3.

Veneer log potential.—Gross veneer log potential includes all 8-foot stem sections with an estimated scaling diameter of 10 inches or more. Unlike saw logs, however, not all tree volume of acceptable size may meet minimum requirements for the product. Most veneer log grading systems have quality limitations on the lowest acceptable grade. Consequently, the analysis illustrated limits gross veneer log potential to the first 24 feet of merchantable stem, for which detailed quality information is available. Results of the analysis will necessarily be conservative. Gross veneer log volume in each diameter class, and distribution of the volume in the first three 8-foot stem sections, are shown in the left-hand columns of table 4.

Visible stem defects that will reduce usable veneer log volume include crook, fork, and fire and lightning scar. Major crook was considered to remove the entire 8-foot block from consideration for veneer. Minor crook, fork, and scar resulted in scaling deductions equivalent to those made in saw logs. Sweep can usually be eliminated in bucking 8-foot veneer blocks. Defect deductions were calculated in the manner previously illustrated for saw logs. Scaling deductions by type of defect and resulting net ungraded log volume—a "first estimate" of net veneer log volume—are shown in table 4. A more refined estimate is obtained when veneer log grades are applied, since some of the ungraded net volume may not meet minimum grade specifications.

The quality of a veneer log depends primarily upon the size of live and dead knots present. To describe the quality of veneer logs in sample stands, an arbitrary grading procedure was adopted. The procedure, based partially on experienced recovery of veneer suited to sheathing grade plywood, uses recorded knot size information to grade each 8-foot veneer block:

Diameters of-- Dead knots	Live knots	Grade
(Inches)		
None	To 2	1
To 2	To 2	2
To 3	Any size	3
Over 3		Unacceptable

The volume of veneer log material graded "unacceptable" and the acceptable net volume, by grade, is shown in the right-hand columns of table 4. Grades 1 and 2 are combined, since the sampled stand contained only a small volume of Grade 1 material. The quality analysis can readily be adjusted to accommodate different grading criteria or end-product requirements. For example, the effect of allowing 4-inch dead knots in Grade 3 can be evaluated directly from inventory data. In the sampled stand, such a change would substantially reduce the "unacceptable" volume.

Table 4.--Analysis of veneer log potential, per acre basis, in the example stand

Tree d.b.h. class (Inches)	Gross veneer log volume[1] Per acre	Distribution by 8-foot block First	Second	Third	Deduction for visual defect Crook	Fork	Major fire scar	Lightning scar	Total	Net veneer log volume Ungraded	Graded Unacceptable	Grades 1 & 2	Grade 3	Total acceptable[2]
	Board feet	- - -	- - -	- - -	Percent	- - -	- - -	- - -	- - -	- - -	- - -	Board feet	- - -	- - -
12	222	100	0	0	4.3	0	0	0	4.3	212	21	85	106	191
14	129	67	33	0	3.5	0	0	0	3.5	124	41	7	76	83
16	182	50	30	20	2.5	.5	0	0	3.0	177	84	46	47	93
18	313	50	29	21	1.3	.9	.4	3.4	6.0	294	134	47	113	160
20	292	43	33	24	1.4	0	0	3.1	4.5	279	165	42	72	114
22	470	43	32	25	.5	0	0	3.0	3.5	454	295	56	103	159
24	403	42	33	25	.4	0	.4	11.5	12.3	353	243	22	88	110
26	362	42	33	25	0	0	0	5.2	5.2	343	274	26	43	69
28	151	41	34	25	0	0	0	10.3	10.3	135	96	6	33	39
30	86	41	33	26	0	0	0	6.6	6.6	80	67	0	13	13
32	35	41	33	26	0	0	0	0	0	35	35	0	0	0
34	17	41	33	26	0	0	0	0	0	17	10	7	0	7
36	17	40	34	26	0	0	5.0	25.0	30.0	12	7	5	0	5
38	33	39	35	26	0	0	0	20.0	20.0	26	26	0	0	0
Total	2,712	49	30	21						2,541	1,498	349	694	1,043

[1]Includes only volume in first 8-foot section of trees in 12-inch diameter class, first and second sections of 14-inch class trees, and first three sections of all trees larger.
[2]Exclusive of volume reduction due to internal defect.

Stud log potential.—Gross stud log volume includes all 8-foot stem sections with scaling diameters of 6.0 to 16.9 inches. Stud logs are typically processed through chipping headrig mills, or mills similarly equipped for the specialty manufacture of studs and dimension stock. As with veneer logs, not all stem sections of the right size may meet minimum quality requirements. The analysis is consequently limited to the first 24 feet of merchantable stem. The maximum scaling diameter limit of 16.9 inches further restricts gross stud log potential to portions of trees in 22-inch and smaller diameter classes. Gross potential volume and distribution by 8-foot stem section are shown in table 5.

The net volume of stud log material was estimated by considering the same scaling defects and deductions applied to veneer logs—crook, fork, and scar. Deductions for visual defect and net ungraded volume are included in table 5.

The quality of a stud log depends upon size and number of knots present. An arbitrary grading procedure, based on log characteristics important in the production of dimension lumber, was used to indicate quality of stud logs in the sample stand. The procedure uses knot size and number information from inventory data to grade each 8-foot log:

Diameters of-- Dead knots	Live knots	Total knots allowed	Grade
(Inches)		(Number)	
To 1	To 2	16 or less	1
To 2	To 2	32 or less	2
To 2	To 3	No limit	3
Over 2	Over 3		Unacceptable

The acceptable net volume of stud log material, by grade, and volume unaccepted, are shown in table 5. Grades 1 and 2 are again combined because of the small volume of Grade 1 logs in the sampled stand. The dead knot size limit was primarily responsible for the high proportion of unaccepted material. Again, reevaluation of the inventory data indicates that allowing 3-inch dead knots in Grade 3 would substantially reduce the unaccepted volume.

Pole potential.—Because stems that meet specifications for commercial poles are usually considerably more valuable for that use than for any alternative, pole potential in a stand should receive careful attention. The potential for pole products is not limited entirely to commercial poles, however; poles of shorter lengths are used in quantity as house logs and in pole frame construction. Gross pole potential is expressed in terms of stems per acre, rather that volumetric measurement. All stems in 10-inch through 20-inch diameter classes were initially considered potential poles. Gross pole potential by tree diameter class is shown in table 6.

Standards for commercial poles are defined in specifications of the American Standards Association (1963). Because of critical strength requirements, the standards are detailed and stringent. Defects that render stems unsuitable for poles include sweep, major crook, fork, lightning scar, and excessive lean (indicative of compression wood). Also inadmissible are excessive knots, generally defined for shorter poles as single knots 4 inches or larger in diameter, or knots aggregating over 8 inches in diameter within a 1-foot stem section.

Short commercial poles, and poles too short to meet commercial standards, are used in substantial numbers in pole frame construction and related uses. There are no standard specifications, other than those developed to meet particular design requirements, for short construction poles. The Forest

Table 5.--Analysis of stud log potential, per acre basis, in the example stand

Tree d.b.h. class (Inches)	Gross stud log volume[1] Per acre	Distribution by 8-foot log: First	Second	Third	Deduction for visual defect: Crook	Fork	Major fire scar	Lightning scar	Total	Net stud log volume: Ungraded	Graded: Unacceptable	Grades 1 & 2	Grade 3	Total acceptable[2]
	Board feet	- - - - - - - -	- Percent -	- - - - - - - -						- - - - - -	- Board feet -	- - - - -		
10	196	67	33	0	2.4	0	0	0	2.4	191	94	5	92	97
12	334	67	22	11	3.1	0	0	0	3.1	324	138	0	186	186
14	150	57	29	14	3.0	0	0	0	3.0	146	94	0	52	52
16	182	50	30	20	2.5	.5	0	0	3.0	177	87	23	67	90
18	313	50	29	21	1.3	.9	.4	3.4	6.0	294	149	18	127	145
20	167	0	58	42	2.0	0	0	3.1	5.1	158	133	0	25	25
22	118	0	0	100	0	0	0	3.0	3.0	114	97	3	14	17
Total	1,460	47	29	24						1,404	792	49	563	612

[1]Includes only volume in first three 8-foot sections of trees in 18-inch and smaller diameter classes, second and third sections in 20-inch class trees, third section in 22-inch class trees, and none in larger trees.
[2]Exclusive of volume reduction due to internal defect.

Products Laboratory has recommended, however, that poles used for framing meet American Standard or equivalent grades (Wood 1957).

Net pole potential was calculated by making appropriate deductions for inadmissible defect. Deductions by type of defect, and resulting net pole potential, are indicated in table 6.

Pole quality or value classes, described by ASA specifications (1963), are based upon pole length and diameter. Because both can be obtained from inventory data, net pole potential can be described in terms of commercial pole classes. Net noncommercial or construction poles, and net commercial poles by pole length and class, are shown in table 6.

Pulpwood potential.—All timber could be utilized for pulpwood (or other wood chip or fiber). The diameter breaking point between pulpwood and other primary product uses is likely to be highly variable. Consequently, all timber in 8-inch and larger diameter classes was considered potential pulpwood. Since the inventory data provide volume information by tree diameter classes, the volume in any range of diameter classes under consideration is immediately available. Gross pulpwood volumes (table 7) were obtained by applying cubic-foot volume tables (Myers 1963) to stand measurement data.

Visible stem quality features other than fire and lightning scars will not significantly affect volume of usable pulpwood. Fire scar will affect net volume both as an absolute reduction of volume and as a source of charred, unsuitable material. Because charred wood must be excluded from pulping operations, it is anticipated that fire-scarred trees will be long butted above the scar. Consequently, a cubic-foot volume deduction equivalent to the lower 4 feet of the merchantable stem was adopted. Lightning scars of the type recorded are similarly often accompanied by charred wood, pitch streaks, and ingrown callus bark. Stems with lightning scar were therefore considered unsuitable for pulpwood, and were culled from gross scale. These scale deduction factors were applied to the proportion of the stand affected by fire and lightning scar. Resulting scale deductions and net pulpwood volumes, by tree diameter class, are shown in table 7.

Specific, well-defined quality criteria have not been developed for pulpwood. Certain quality specifications are often used by purchasing firms, however, in defining the type of material they will accept. It seems probable that, in the future, pulpwood quality classes will be defined.

Stem characteristics that might reduce the suitability of the stem for pulping include severe crook or sweep and fork, which make handling difficult, reduce the solid wood volume of a load, and interfere with debarking or mechanical grinding. Compression wood, indicated by lean, may significantly reduce pulp yields. The cellulose content of severe compression wood has been found to be as much as 50 percent below normal (Hale et al. 1961). Excessive numbers of large knots may reduce suitability of pulpwood for grinding and reduce value for chemical pulping. Pulpwood quality classes based upon these or other stem characteristics can readily be distinguished on the basis of stem quality inventory data. The ability to stratify pulpwood into such quality classes is important in appraising suitability for specific pulping processes and handling methods.

Application to Additional Products

The preceding examples of how inventory data can be used to estimate product potential in a

Table 6.--Analysis of pole potential, per acre basis, in the example stand

Tree d.b.h. class (Inches)	Gross poles								Net poles										
	Total	Deduction for visual defect							Noncommercial lengths		Commercial lengths and ASA classes								Total[1]
		Sweep	Major crook	Fork	Lean (10°+)	Lightning scar	Oversize knots	Total	10 ft. and under	15 ft.	18 and 20 ft.		25 ft.			30 ft.		35 ft.	
											3	6	3	4	5	2	5	2	
	Number	Percent							Number										
10	13.0	1.8	0	0	1.8	0	20.0	23.6	5.0	1.2	0	2.4	0	0	1.2	0	0.1	0	9.9
12	7.4	0	4.3	0	2.2	0	26.0	32.5	2.4	1.6	.4	0	0	.2	.2	0	.2	0	5.0
14	2.1	0	5.3	0	5.3	0	30.0	40.6	.9	.2	.1	0	0	0	0	0	0	0	1.2
16	1.8	4.9	4.9	4.9	19.8	0	34.0	68.5	.3	.1	0	0	.1	0	0	.1	0	0	.6
18	2.2	10.3	0	3.4	10.1	6.7	36.0	66.5	.4	0	.1	0	0	0	0	.1	0	.1	.7
20	1.4	0	0	4.1	12.4	8.2	38.0	62.7	.2	.1	0	0	.1	0	0	.1	0	0	.5
Total	27.9								9.2	3.2	.6	2.4	.2	.2	1.4	.3	.3	.1	17.9

[1]Exclusive of volume reduction due to internal defect.

Table 7.--Analysis of pulpwood potential, per acre basis, in the example stand

Tree d.b.h. class (Inches)	Gross volume	Deduction for visual defect			Net volume[1]
		Fire scar	Lightning scar	Total	
	Cubic feet	- - - Percent - - -			Cubic feet
8	97	0.7	0	0.7	96
10	99	0	0	0	99
12	92	0	0	0	92
14	39	0	0	0	39
16	49	0	0	0	49
18	90	.8	6.7	7.5	83
20	75	.7	8.2	8.9	68
22	116	.5	5.9	6.4	109
24	95	.6	24.7	25.3	71
26	80	0	12.1	12.1	70
28	33	0	31.0	31.0	23
30	18	2.1	13.3	15.4	15
32	7	0	0	0	7
34	4	0	0	0	4
36	4	6.7	50.0	56.7	2
38	8	5.4	40.0	45.4	4
Total	906				831

[1]Exclusive of volume reduction due to internal defect.

timber stand are by no means exhaustive. If additional products command attention due to changing utilization patterns or consumer demands, the appropriate stand volumes and quality criteria can be selected from existing inventory data to estimate stand potential.

Raw material quality standards also change with time. New standards are developed to meet the needs of new products, and existing standards are revised. Most such standards will incorporate as primary grading criteria some of the stem quality features described by inventory data. Stand potential for the particular product can be reevaluated in terms of these new quality standards by selecting and applying appropriate stem quality information. Thus the inventory system provides a high degree of flexibility in meeting future product quality appraisal needs.

Comparison with Quality Observed in Felled Timber

Timber on the example area was subsequently clearcut, which provided an opportunity to compare quality evaluations made in standing and felled timber. Two-chain sample strips, which included one-fourth of the study area and contained 1,562 merchantable trees, were randomly located across the area. Each tree was felled, scaled, and graded in standard lengths for each primary product. Grading systems used in interpreting standing timber inventory data were also used in evaluating primary products in felled trees.

Timber suitability and grade distribution, judged from both inventory data and felled trees, were compared for four products (table 8). The comparisons indicate that methods of inventorying standing timber quality can provide a reasonable estimate of product potential for a range of primary products.

Inventory Information as a Basis for Decision

An inventory based on timber quality provides a wealth of information for both stand management and utilization planning. A primary objective of timber management is to produce salable raw material, within the restrictions imposed by other forest uses. A primary objective of timber utilization is to optimize the use of the resource within the limits of existing technology and product demand. Both objectives require knowledge of the physical characteristics of the stand, and the effect of these characteristics on product yield and quality. A multiproduct inventory system can provide such information.

The timber manager needs to know which type of products the stand can and should be directed toward. Although his initial concern may be with growth rates, volumes, and associated factors, of equal concern should be the occurrence of stem features that affect yield and quality for particular products. He needs to know which stem features most restrict utilization potential, and the frequency with which they occur in the stand. He needs to know how much the utilization potential for specific products is affected by stem size distribution. This type of stand information gives timber managers a basis for making management decisions. They can adequately assess the effect of a given stand treatment upon present and future product potential.

Utilization planning requires perhaps even more complete knowledge of the resource. A detailed

Table 8.--Comparison of timber quality evaluations made in standing and felled timber in the example stand

Primary product	Tree size classes included	Log grade	Quality evaluation	
			Inventory (standing)	Felled
	Inches in d.b.h.		Percent of gross volume	
Saw logs	11.0 and over	3 & better	5.0	6.9
		5	95.0	93.1
Veneer logs	11.0 and over	1 & 2	13.7	14.2
		3	27.3	28.3
		([1])	59.0	57.5
Stud logs	9.0 - 22.9	1 & 2	3.5	1.0
		3	40.1	38.5
		([1])	56.4	60.5
			Stems per acre	
Commercial poles, 25 ft. and over	9.0 - 20.9	--	2.5	1.9

[1]Material graded unacceptable for the product, based on the three-grade arbitrary grading systems described.
Note: "--" indicates not applicable.

Table 9.--Net primary product potential, per acre basis, in the example stand[1]

Tree d.b.h. class (Inches)	Net volume by grade									Commercial poles by height class				Pulpwood volume
	Saw logs			Veneer logs			Stud logs							
	Grade 3 & better	Grade 5	Total	Grades 1 & 2	Grade 3	Total	Grades 1 & 2	Grade 3	Total	18 and 20 ft.	25 ft.	30 ft. +	Total	
	Board feet, Scribner									Number				Cubic feet
8	--	--	--	--	--	--	--	--	--	--	--	--	--	96
10	--	--	--	--	--	--	5	92	97	2.4	1.2	0.1	3.7	99
12	0	327	327	85	106	191	0	186	186	.4	.4	.2	1.0	92
14	0	158	158	7	76	83	0	52	52	.1	0	0	.1	39
16	7	186	193	46	47	93	23	67	90	0	.1	.1	.2	49
18	7	323	330	47	113	160	18	127	145	.1	0	.2	.3	83
20	17	316	333	42	72	114	0	25	25	0	.1	.1	.2	68
22	31	543	574	56	103	159	3	14	17	--	--	--	--	109
24	11	445	456	22	88	110	--	--	--	--	--	--	--	71
26	36	404	440	26	43	69	--	--	--	--	--	--	--	70
28	10	166	176	6	33	39	--	--	--	--	--	--	--	23
30	12	93	105	0	13	13	--	--	--	--	--	--	--	15
32	0	47	47	0	0	0	--	--	--	--	--	--	--	7
34	12	12	24	7	0	7	--	--	--	--	--	--	--	4
36	9	8	17	5	0	5	--	--	--	--	--	--	--	2
38	10	29	39	0	0	0	--	--	--	--	--	--	--	4
Total	162	3,057	3,219	349	694	1,043	49	563	612	3.0	1.8	.7	5.5	831

[1]Exclusive of volume reduction due to internal defect.
Note: "--" indicates not applicable.

inventory of timber and its quality is indispensable to the wood industry. Optimum utilization of timber has long been hampered by inadequate characterization of the raw material. Inventory information provides a reliable basis for interproduct comparisons in determining optimum uses.

A typical analysis of product potential in a timber stand has been described in the preceding section. To help evaluate utilization alternatives, estimated grade and net volume information for each primary product can be combined in a "product schedule" for the sampled stand. Table 9 summarizes estimated net product potential, by grade or quality class, for each diameter class of trees. Maximum potential is shown for each product. A similar schedule can also be developed for selective allocation of the timber to several or all products in order of preference. Allocation of a log for one product would then preclude its consideration for any others. This type of schedule requires prior ranking of potential products according to value or preference. Schedules such as this provide the kind of resource information needed to evaluate potential for a range of primary products and make choices between alternative products. Applied on a broad scale, such information can provide guidance for timber management planning and wood industry development.

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The timber quality inventory described recognizes and measures the basic stem characteristics and defect features that influence quantity and quality for most primary products. Stem features measured on sample trees include form defects, scar defects, and knot or limb characteristics. Timber inventory data obtained are used in conjunction with standard methods of estimating volume, scaling, and grading to estimate:

(1) Gross volume suitable for a primary product;

(2) Probable volume reduction due to visual scaling defects, and remaining net volume suited to the product;

(3) Quality of the timber in terms of existing grading or quality classification systems.

Key Words: Forest measurement, forest products, _Pinus ponderosa_, timber quality inventory.

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The timber quality inventory described recognizes and measures the basic stem characteristics and defect features that influence quantity and quality for most primary products. Stem features measured on sample trees include form defects, scar defects, and knot or limb characteristics. Timber inventory data obtained are used in conjunction with standard methods of estimating volume, scaling, and grading to estimate:

(1) Gross volume suitable for a primary product;

(2) Probable volume reduction due to visual scaling defects, and remaining net volume suited to the product;

(3) Quality of the timber in terms of existing grading or quality classification systems.

Key Words: Forest measurement, forest products, _Pinus ponderosa_, timber quality inventory.

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About The Forest Service. . . .

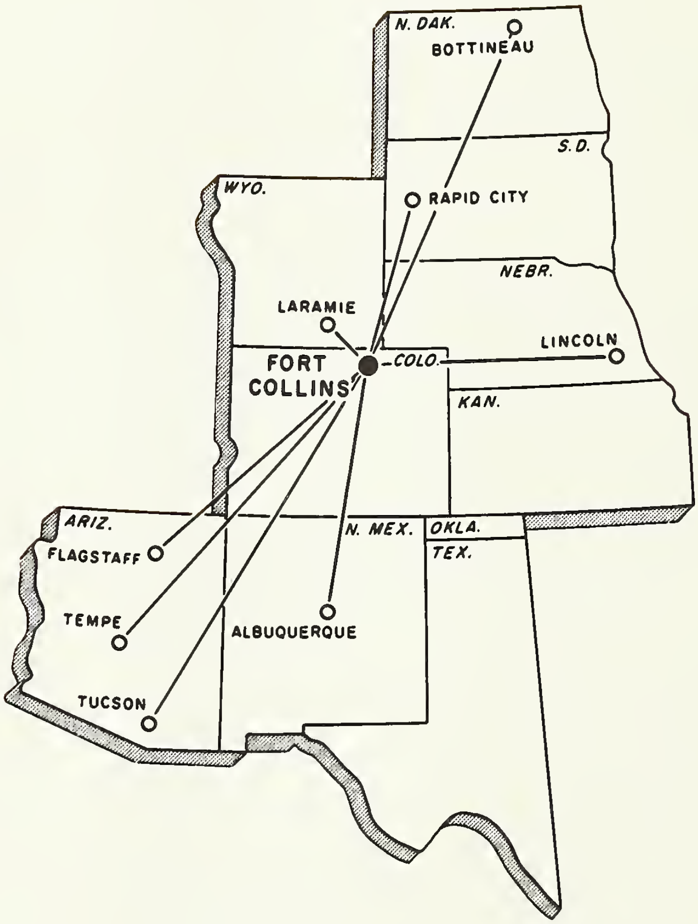
As our Nation grows, people expect and need more from their forests—more wood, more water, fish and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U. S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.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